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Petrology, mineral chemistry, and zircon U-Pb geochronology of the Baishiquan Ni-Cu–bearing mafic-ultramafic intrusion, central Tianshan, Xinjiang, NW China: Evidence for multi-stage magmatic activity

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The Central Asian Orogenic Belt (CAOB) is a Phanerozoic juvenile crustal growth Cordilleran-type orogenic belt. The Baishiquan mafic-ultramafic intrusions are associated with a magmatic Ni–Cu–(PGE) sulfide deposit in northwestern China in the southern part of the CAOB. There are three mafic-ultramafic intrusions named No.1, No.8, and No.17, respectively. Both the No.1 and No.8 intrusions consist of olivine websterite, lherzolite, and plagioclase-bearing lherzolite, whereas the No.17 intrusion is composed of gabbro-diorite, gabbro, and gabbronorite. The websterite and lherzolite are the main Ni-Cu ore-bearing rocks. Pyrrhotite, pentlandite, and chalcopyrite are the main ore minerals. The grade of Ni is 0.28-0.44% and for Cu is 0.20-0.84%.

Our new zircon U-Pb isotope data using the CAMECA IMS 1280 ion microprobe reveal that the three intrusions formed ~40 myr apart. The No.1 ultramafic Intrusion was emplaced at 267.9±1.9 Ma, the No.17 mafic intrusion was emplaced at 277.8±1.7 Ma, and the No.8 ultramafic intrusion was emplaced at 307.5±2.4 Ma.

The whole rock major oxides and olivine component with the highest Fo value (Fo=85) are interpreted to indicate that the estimated parental magma contains 14.1 weight % MgO and it might be a high-Mg tholeiitic magma. The MgO content of this intrusions is higher than the other Ni–Cu-bearing mafic-ultramafic intrusions in the eastern Tianshan, which represent high degree partial melts. The whole rock trace element data show relative enrichments in large ion lithophile elements (LILE, Rb, Ba, Sr, etc.), depletion in high field strength elements (HFSE, Nb, Ta, Zr, Hf, etc.), and enrichments in the light rare earth elements with right-inclined REE distribution patterns. According to these geochemical characteristics, and combining these with isotope characteristics, the parent magma originated from the high-Mg tholeiitic magma in the asthenospheric mantle that might have undergone contamination by early subducted oceanic crustal material.